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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/817,056	03/27/2001	Kai Yang	50432-067	9188

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McDERMOTT, WILL & EMERY
600 13th Street, N.W.
Washington, DC 20005-3096

EXAMINER

NGUYEN, THANH T

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 10/26/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/817,056

Applicant(s)

YANG ET AL.

Examiner

Thanh T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on 18 August 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) 13-20 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 6-12 is/are allowed.
- 6) ☒ Claim(s) 1-5 and 21-23 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

In view of the appeal brief filed on June 5, 2000, PROSECUTION IS HEREBY REOPENED. New grounds of rejection are set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

- (a) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office action is final); or,
- (b) request reinstatement of the appeal.

If reinstatement of the appeal is requested, such request must be accompanied by a supplemental appeal brief, but no new amendments, affidavits (37 CFR 1.130, 1.131 or 1.132) or other evidence are permitted. See 37 CFR 1.193(b)(2).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-2, 5, 21-22 are rejected under 35 U.S.C. 102(e) as being anticipated by Huang et al. (U.S. Patent No. 6,919,638).

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Referring to figures 1-14, Huang et al. teaches a method of manufacturing a semiconductor device:

Forming a single first dielectric layer (20) overlying a substrate (10, see figure 1),

Forming a first barrier layer (40, silicon oxide or standard dielectric material which has the dielectric constant between silicon dioxide and silicon nitride or between 3.7 to 7.0), comprising a first dielectric barrier material of silicon nitride (30) on the single first dielectric layer (20),. It is inherent that the material that has the dielectric constant between the Silicon dioxide and silicon nitride would be silicon oxynitride has a dielectric constant of about 4.3-7 which is between 3.7 to 7.0.

Etching to form a single opening (54) entirely within and defined by side surfaces and a bottom of the single first dielectric layer and a bottom (see figure 2),

Forming a second barrier layer (32, silicon nitride, see figures 3, col. 5, lines 32-37, col. 4, lines 39-49, meeting claim 2), comprising a second dielectric barrier material of SiN (32) different from the first dielectric barrier material (40, SiON), on and in contact with an entire upper surface of the first barrier layer (30, figure 3, wherein the second dielectric barrier (32) is on entire upper surface of the barrier layer (30) overlying the single first dielectric layer (20), on the side surfaces of the first dielectric layer (20) defining the first opening and on the bottom of the opening (54),

Etching, with selectivity to the first barrier layer (40), to remove the second barrier layer (32) from, and stopping on, the upper surface of the first barrier layer (40), and to remove the second barrier layer (32) from the bottom of the single opening (54), leaving a portion of the

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second barrier layer (32) as a liner (32) on the side surfaces of the single first dielectric layer (20) defining the single opening (54, see figure 4, col. 5, lines 28-41) and

Filling the opening with metal (70, copper, see col. 5, lines 60-67, meeting claim 5) forming an overburden on the first dielectric layer (see figure 4);

Planarizing to form a lower metal feature (76, see figure 5, col. 6, lines 4-8).

Regarding to claim 2, the first and second dielectric barrier materials are selected from the group consisting of silicon nitride, silicon oxynitride (see col. 3, lines 51-54, col. 5, lines 9-12).

Regarding to claim 21, etching to form the single opening (54) having entire side surface, which are substantially parallel (see figures 2).

Regarding to claim 22, etching to remove the second barrier layer (32) leaving a portion of the second barrier as a liner (32) on the side surfaces of the single first dielectric layer (20) with a gap between an upper surface of the liner and an upper surface of the barrier layer (see figure 4).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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Claims 2-4, 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al. (U.S. Patent No. 6,919,638) as applied to claims 1, 5, 21-22 in view of Hasegawa et al. (U.S. Patent No.) and further in view of Wolf et al. "Silicon processing for the VLSI Era", vol. 1, pages 191-195.

Referring to figures 1-14 Huang teaches a method of forming a single opening by depositing the first dielectric layer, depositing a first barrier layer with a dielectric constant between the silicon oxide and silicon nitride 3.7 and 7.0, and depositing a second barrier layer (silicon nitride) by LPCVD. However, the reference does not specifically teach the first barrier layer is made of SiON with a dielectric constant between the silicon oxide and silicon nitride 3.7 and 7.0, the first and second barrier layer is depositing second barrier layer of silicon nitride (32) by chemical vapor deposition, the specific thickness of the first barrier layer and second barrier layer, and the width of the gap between the sidewall of the opening.

Hasegawa et al. teaches the stack of thin insulating films wherein the silicon oxide has a relative dielectric constant about 4.0, the silicon oxynitride film has a relative dielectric constant about 4-6, and the silicon nitride film has the relative dielectric constant about 6.0.

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would chose the silicon oxynitride film which has the dielectric constant between the silicon oxide and silicon nitride in process of Huang et al. as taught by Hasegawa et al. because silicon oxynitride film is known in the art to have the dielectric constant between the silicon oxide and the silicon nitride and oxynitride film also known to provide a low stress and crack resistance in semiconductor device.

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Wolf teaches silicon nitride and silicon oxynitride are known to deposit by CVD (pages 191-195).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would deposit the silicon nitride and silicon oxynitrid elayer by CVD process in Huang et al. as taught by Wolf et al. because deposit by CVD process is known in the art to improve thermal stability, low compressive stress, crack resistance and as well as good step coverage.

It would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made to optimize the gap range between an upper surface of the liner and an upper surface of the first barrier layer, since it has been held that where the general conditions of a claim are disclosed in the prior art (i.e.-the gap between the two layer), discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233 (CCPA 1955).

The specification contains no disclosure of either the critical nature of the claimed arrangement (i.e.- wherein gap, thickness range is about 50-500 Å) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the applicant must show that the chosen limitations are critical. In re Woodruff, 919 F.2d 1575, 1578 (FED. Cir. 1990).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form the barrier layer with any specific thickness, gap range in process of Huang et al. because choose the optimum thickness or gap range for a layer

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in the device would involve only routine skill in the art in order to optimize the process of forming a semiconductor device.

Allowable Subject Matter

Claims 6-12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims because inter alia the prior art of record fails to disclose nor suggest to combine forming a third dielectric barrier layer on the first barrier layer and on upper surface of the lower metal feature, a second dielectric layer on the third dielectric barrier layer, a fourth dielectric barrier layer on the second dielectric layer, forming a third dielectric layer on the fourth dielectric barrier layer, forming a fifth dielectric barrier layer on the third dielectric layer, etching to form a dual damascene opening in the second and third dielectric layers over the lower metal feature, forming a sixth dielectric barrier layer comprising a sixth dielectric barrier material different from the first, fourth and fifth dielectric layers in the dual damascene opening, and filling the dual damascene opening with metal to form a metal line connected to an underlying metal via in the claimed invention as a whole.

Response to Arguments

Applicant's arguments filed 4/29/05 have been fully considered but they are not persuasive.

Applicant contends that Chooi et al. does not teach forming a single opening in a single dielectric layer. In response to applicant that Lou teaches forming a single opening in a single dielectric layer (see col. 7, lines 34-43).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (571) 272-1695, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:00AM to 3:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached on (571) 272-1702. The fax phone number for this Group is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See MPEP 203.08).

A handwritten signature in black ink, appearing to read 'Thanh', with a long horizontal stroke extending to the right.

Thanh Nguyen
Patent Examiner
Patent Examining Group 2800